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RED SALMON SPAWNING GROUND SURVEYS IN THE

NUSHAGAK AND TOGIAK DISTRICTS, BRISTOL BAY,

1965

By:

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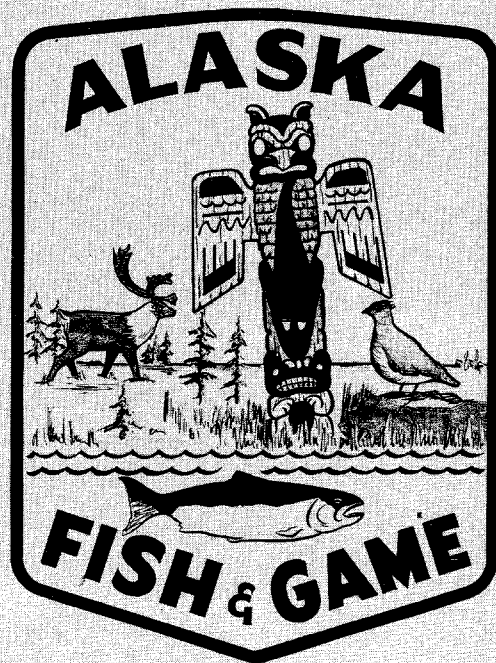
INTRODUCTION AND BACKGROUND

Accurate determination of red salmon (Oncorhynchus nerka) spawning escapement and distribution on the spawning grounds is vital to those responsible for management and regulation of the fishery. Extensive aerial and ground surveys of spawning grounds in the Nushagak and Togiak districts of Bristol Bay have been conducted from 1946 to 1959 by the Fisheries Research Institute of the University of Washington and since 1960 by the Alaska Department of Fish and Game.

The purpose of the survey program is to provide accurate estimates of abundance and distribution of red salmon in the various important spawning areas. In systems where counting towers are not situated, aerial surveys are used to determine spawning escapements as well as distribution. Distribution of fish on the spawning grounds is an important factor in the determination of optimum escapement and utilization of types of spawning areas to evaluate different levels of escapement.

Systems surveyed included primary red salmon spawning areas in the Nushagak and Togiak districts: Wood River Lakes, Igushik Lakes, Lake Nunavaugaluk, Tikchik Lakes, Nushagak-Mulchatna River system, Togiak Lakes and tributaries and the Kulukak system (Figures 1-8).

AERIAL SURVEY METHODS

Survey Methods

Total red salmon escapement to Wood River, Igushik, Tikchik and Togiak Lakes were estimated by the tower counting method. Escapements to Lake Nunavaugaluk, Nushagak-Mulchatna and Kulukak River systems and tributaries of the Togiak River were estimated by aerial surveys.

All aerial observations were recorded on detailed maps (scale 1/2 inch =
1 mile) of the spawning areas while flying over the spawning grounds in a Cessna
180 floatplane at speeds from 70 to 80 miles per hour. Generally a survey alti-
tude of 500 feet was maintained, however the altitude varied with light intensity,
wind conditions and the area being surveyed. Estimates of fish were made in
convenient units of 100's or 1,000's, tallied on a hand counter, and immediately
transferred to spawning ground maps. Polaroid glasses were worn at all times to
reduce water surface glare.

Surveys were timed to coincide with peak spawning periods in each area.
However, adverse weather conditions in the fall of 1965 made adherence to the
peak spawning schedules very difficult.

Three distinct types of spawning areas are utilized by red salmon in the
Nushagak and Togiak districts: creeks, rivers and beaches, and all having differ-
ent peak spawning periods.

Creeks are commonly classified as either spring-fed, lake-fed or those
resulting primarily from surface run-off. Spring-fed creeks are usually of small
size, however they are the most important producers of the three types. Lake-fed
creeks are intermediate in size and importance, while run-off creeks are largest
in size but usually poor spawning areas. Creek spawning generally occurs early
in the season, the fish schooling off the creek mouths in late July and the peak
of spawning occurring from August 1 to 15.

Important river spawning areas are almost always streams which connect
two lakes or those which serve as the outlet of a lake system. Large spawning
populations are frequently found in river areas, which are intermediate in spawn-
ing time between creeks and beaches, with peak spawning between August 25
and September 5.

Beach spawning along the shores of lakes usually occur in areas where
strong flows of spring or ground water occurs in conjunction with suitable gravel
bottoms. Spawning may occur in very shallow water only a few inches deep to
depths of 100 feet or more. Beach spawning peaks late in the season, generally
between September 1 and October 15.

Supplemental ground counts by personnel of the Fisheries Research
Institute and the Alaska Department of Fish and Game provided valuable com-
parisons with aerial estimates. The writer is particularly indebted to Mr. Ken
Roberson of the Fisheries Research Institute for his ground counts on the Wood
River Lakes.

Total Population Estimates by Area

Total spawning population estimates by area are derived by use of the

chain-link index method. The chain-link method makes use of the ratio of peak aerial spawning ground estimates by comparing the estimates from one year with the succeeding year. This method which weights the known total escapement as obtained by tower counts, produce estimates of the total population in each of the major spawning areas. In areas where tower counts are not available, the chain-link method is used to determine an estimate of the total system spawning population.

In applying this technique to the 1965 data, peak spawning estimates from all areas within a given lake or river system were summed. The 1965 data was then compared with similar peak estimates made in 1964 and the 1965/1964 ratio was obtained by dividing the 1965 aerial estimates by the 1964 aerial estimates (Tables 1-5). The 1965 ratio was then multiplied by the 1964 total population estimate which gave the 1965 preliminary population estimates for each lake and river within the system (Tables 6 and 7). The preliminary population estimates were then revised to agree with the tower counts by distributing the difference among all areas. Revision of spawning populations in each area within a system is necessary because the aerial survey data does not completely fulfill the requirements necessary to accurately reflect changes in populations from year to year. In carrying out this revision, all data from the surveys were used in producing total population estimates which were considered to be most realistic. Information which had a bearing on this revision included: (1) duration of spawning in various areas, (2) timing and coverage of the surveys, (3) factors affecting the reliability of the survey and (4) personal impressions of the writer as to reasonableness of the estimate.

The reliability and accuracy of the chain-link method can be tested by comparing total population estimates before revision with tower enumeration figures (Table 8). The sum of major spawning unit population estimates in the Nushagak and Togiak districts has only varied from - 3.6 to + 7.9 percent (average + 1.7 percent) from known total populations during the years 1960 to 1965 when the aerial survey program was conducted by three different observers. A further discussion of the chain-link method can be found in Nelson, 1965.

NUSHAGAK DISTRICT

The Nushagak district of Bristol Bay covers an area of approximately 14,000 square miles (Mertie, 1938), the largest drainage of the Bristol Bay watersheds. Five important red salmon systems are found within the boundaries of the district and are discussed in the following sections: Wood River Lakes, Igushik Lakes, Lake Nunavaugaluk, Tikchik Lakes and the Nushagak-Mulchatna River system.

Wood River Lakes

Peak aerial estimates of red salmon for the Wood River Lakes in 1964 and 1965, and peak estimate ratios for these two years are shown in Table 1. Preliminary population estimates and estimates adjusted to the tower count total are shown in Table 6.

The 1965 escapement of 675,200 red salmon to the Wood River Lakes contributed 61.4 percent of the total Nushagak district escapement (Table 6). The Wood River Lakes, with 174 square miles of surface area and their connecting rivers and tributary streams, have contributed over 70 percent of the district escapement and have been the most important red salmon spawning areas of the Nushagak district during 1959-1965 (Table 9 and Nelson, 1965).

Distribution of spawners was similar to the brood year escapement of 1961 (Church, 1963). Three areas, Agulowak River, Lake Nerka and Agulukpak River, accounted for 70 percent of the estimated escapement (Table 9). Both the Agulowak and Agulukpak Rivers received over 100,000 spawners with the Agulukpak River population of 130,800 red salmon being the largest estimated for that river since the surveys commenced in 1946.

Lake Aleknagik received over 7 percent of the Wood River Lakes escapement, the largest since 1959 and was primarily the result of an increase in number of creek spawners. The upper Wood River Lakes; Lakes Beverly, Mikchalk and Kulik accounted for only 13 percent of the estimated escapement, far below the average of 27 percent for the past five years (Table 9).

The most important beach spawning areas in the Wood River Lakes were N4 to N6 Beach, Anvil Bay and Lynx Lake Beaches of Lake Nerka; D Slough Beach of Little Togiak Lake and Hardluck Bay and Silver Horn beaches of Lake Beverly (Table 1).

Creek spawning was generally poor, with a few notable exceptions, namely Ice, Hansen, Bear and Happy Creeks of Lake Aleknagik and Pick Creek of Lake Nerka (Table 1).

Spawning in rivers between lakes accounted for over 65 percent of the escapement to the Wood River Lakes (Table 13). Wood, Little Togiak, Peace, Wind and Grant Rivers all failed to show an increase over the 1964 populations, however the Agulowak and Agulukpak Rivers each had three times more spawners than in 1964.

Distribution of spawners in the three major types of spawning areas; creeks, beaches and rivers, are shown in Table 13. Large returns to the Agulowak and Agulukpak Rivers, and small returns to the spawning creeks and beaches throughout the lake system resulted in an increase in percent of river spawning and a decline in percent of creek and beach spawning over 1964 (Table 13).

Percent of fish accounted for by peak aerial estimates for each system is derived by dividing the sum of all peak survey estimates by the total escapement obtained from tower counts. Regardless of the method employed, spawning ground surveys produce estimates of only a portion of the spawning populations (Table 12). Peak aerial or ground estimates account for only a portion of the total population because by the time the last fish enters the spawning area many of the earlier spawners have disappeared and are no longer available to be observed.

Percent of total escapement accounted for by peak aerial estimates in the Wood River Lakes in 1965 was 64.6 percent (Tables 11 and 12). This is an increase over previous years and was made possible by the increase in river spawning. Peak survey estimates for major river areas between lakes are assumed to more nearly approach the total river spawning population than in the case of creek and beach spawning estimates. This assumption is made because: (1) duration of spawning in rivers is relatively short (August 25-September 5), which allows viewing of nearly the total spawning population at peak of spawning, and (2) the broad rivers, with clear banks and limited depth provide conditions for viewing a higher proportion of fish present than in most creek and many beach areas.

In the case of creek and beach areas the assumption is made that the sum of peak survey estimates in these areas is a constant fraction of the total number of spawners.

Igushik Lakes

Peak aerial estimates of red salmon for the Igushik Lakes in 1964 and 1965, and peak estimate ratios for these two years are shown in Table 2. Preliminary population estimates and estimates adjusted to the tower count are shown in Table 6.

The 1965 escapement of 180,800 red salmon to the Igushik Lakes constituted 16.5 percent of the total Nushagak district escapement (Table 6). The Igushik Lakes system, which has a surface area of 27 square miles, is second in importance in the Nushagak district and has contributed over 17 percent of the district escapement during 1959-1965 (Table 9 and Nelson, 1965).

Primary spawning areas in the Igushik system are located along the Lake Ualik beaches and in the Kathleen River complex. Lake Amanka supports a relatively minor percentage of the population (Table 6).

Kathleen River, Ongoke River, Frances Creek and westshore beaches of Lake Ualik were the most important spawning areas in 1965 and contributed well over 80 percent of the total system escapement (Table 2).

Distribution of spawners in the three major types of spawning areas is shown in Table 13. Large returns to the beach areas accounted for over 59 percent of the escapement, the highest in the last seven years of observation (Table 13). Creek spawning compared closely with the seven year average, while river spawning decreased in importance from 1964 (Table 13).

Percent of the total escapement accounted for by peak aerial estimates in the Igushik Lakes system was 44.5 percent, which compares favorably with past years for this system (Tables 11 and 12).

Lake Nunavaugaluk (Snake River Lake)

Peak aerial estimates of red salmon for Lake Nunavaugaluk in 1964 and 1965, and peak estimate ratios for these two years are shown in Table 3.

The 1965 escapement of 12,000 red salmon to Lake Nunavaugaluk is based solely on aerial surveys (Table 6). Spawning populations in Lake Nunavaugaluk contributed 1.1 percent of the total Nushagak district escapement in 1965 (Table 6). Lake Nunavaugaluk, which has a surface area of 25 square miles is of minor importance in the Nushagak district and has produced only 2 percent of the district escapement from 1959-1965 (Table 9 and Nelson, 1965).

Well over 60 percent of the spawning population were concentrated along the westshore and eastshore beaches, with the remainder being thinly distributed in Killian Creek and other portions of the lake (Table 3).

Beach spawning accounted for over 74 percent of the estimated escapement and was higher than the average for 1959-1965 (Table 13). Creek and river spawning was similar to the seven year average.

Tikchik Lakes

Peak aerial estimates of red salmon for the Tikchik Lakes in 1964 and 1965, and peak estimate ratios for these two years are shown in Table 4. Preliminary population estimates and estimates adjusted to the tower count are shown in Table 6.

The 1965 escapement of 203,100 red salmon to the Tikchik Lakes constituted 18.5 percent of the total Nushagak district escapement (Table 6). The Tikchik Lakes system, which has a surface area of 117 square miles, is third in importance in the Nushagak district and has contributed over 9 percent of the district escapement during 1959-1965 (Table 9 and Nelson, 1965).

The most distinctive feature of the 1965 spawning ground distribution

was the very large return of 88,800 spawners to Nuyakuk Lake (Table 6). The majority of Nuyakuk Lake spawners were found along the southshore beaches and in Mirror Bay (Table 4). Allen River Beach in Lake Chauekuktuli continued to be the most important spawning area in that lake (Table 4).

Large returns to beach areas in the Tikchik system in 1965 accounted for the increase in beach spawning over the average, while the importance of creek and river spawning was comparable to previous years (Table 13).

Percent of total escapement accounted for by peak aerial estimates in the Tikchik Lakes system was 46.7 percent, which compares favorably with past years for this area (Tables 11 and 12).

Nushagak-Mulchatna River System

Peak aerial estimates of red salmon for the Nushagak-Mulchatna River system in 1964 and 1965, and peak estimate ratios for these two years are shown in Table 3.

The 1965 escapement of 28,200 red salmon to the Nushagak-Mulchatna system is based solely on aerial surveys (Table 6). Spawning populations in the Nushagak-Mulchatna system contributed 2.6 percent of the total Nushagak district escapement in 1965 (Table 6). The Nushagak-Mulchatna system is of minor importance in red salmon production and has contributed only 2 percent of the district escapement from 1961-1965 (Table 9).

Primary red salmon spawning grounds are found on the Nushagak and Mulchatna Rivers, and in some years in the Okstukuk Lakes, which head the Kokwok River. In 1965, areas in order of importance were the Nushagak River, Mulchatna River and Okstukuk Lakes (Table 6).

Red salmon were observed in small widely scattered groups in the Nushagak and Mulchatna Rivers, and these red salmon populations have not been listed in Table 13. All three types of spawning areas are represented in this system; however, it is difficult to differentiate between creek and river spawning.

Complete coverage of all tributaries was not attained, and some spawning areas were very probably missed in the survey. It is unlikely, however, that the numbers of fish missed would be sufficient to change the Nushagak system's total population estimate significantly.

TOGIAK DISTRICT

The Togiak district of Bristol Bay covers an area of approximately 4,000

square miles. Three important red salmon systems are found within the boundaries of the district: Togiak Lakes, Togiak Tributaries and the Kulukak River system.

Togiak Lakes

Peak aerial estimates of red salmon for the Togiak Lakes in 1964 and 1965, and peak estimate ratios for these two years are shown in Table 5. Preliminary population estimates and estimates adjusted to the tower count are shown in Table 7.

The 1965 escapement of 88,400 red salmon to the Togiak Lakes constituted 78.4 percent of the total Togiak district escapement (Table 7). The Togiak Lakes system, which has a surface area of approximately 18 square miles, is the most important spawning area in the district and has contributed over 79 percent of the district escapement during 1959-1965 (Table 10 and Nelson, 1965).

Poor weather conditions and high water resulted in inadequate aerial observation of the spawning grounds in 1965. Beach spawning population estimates were derived by analyzing the age composition of the escapement and then relating the distribution of parent year stocks to the escapement in 1965. The average percent of fish accounted for was adhered to (Table 12), and the final percent fish accounted for was 48.8 percent (Table 11). The writer fully realizes the inaccuracies that may exist in the spawning ground distribution apportioned in this manner, however, it is believed that the distribution is reasonable and the best that can be made with the data on hand.

Spawning ground distribution is shown on Table 13. Large returns to the Zwischen River resulted in an increase in river spawning over the average, while creek and beach spawning was similar to previous years (Table 13).

Togiak Tributaries

Peak aerial estimates of red salmon for the Togiak tributaries in 1964 and 1965, and peak estimate ratios for these two years are shown in Table 5.

The 1965 escapement of 8,100 red salmon is based solely on aerial surveys (Table 7). In past years the various tributaries contributed over 13 percent of the total district escapement, however in 1965 only 7.2 percent of the district escapement utilized the tributaries (Table 7).

Gechiak and Ongivinuk Lake systems supported over 91 percent of the tributary spawning populations. Gechiak Lake supports both creek and beach spawning populations, while Ongivinuk Lake and Pungokepuk Lake populations are entirely beach spawners.

Kulukak Lake System

Peak aerial estimates of red salmon for the Kulukak Lake system in 1964 and 1965, and peak estimate ratios for these two years are shown in Table 5.

The 1965 escapement of 16,300 red salmon is based solely on aerial surveys (Table 7). Kulukak River and Lake and the Tithe Creek ponds usually support about 10 percent of the total Togiak district escapement. However, due to the large return to the Tithe Creek pond area in 1965, over 14.5 percent of the district escapement was located there.

Tithe Creek spawning takes place primarily in numerous spring-fed ponds which drain into the creek. Spawning takes place in both the Kulukak River and Kulukak Lake, with the majority of the fish being widely scattered in small groups along the entire river area.

SUMMARY

1. The Alaska Department of Fish and Game continued aerial surveys of red salmon spawning grounds in the Nushagak and Togiak districts for the sixth straight year.

2. Three major types of spawning areas utilized by red salmon; creeks, rivers and lake beaches, were surveyed in a manner similar to previous years.

3. Red salmon escapement to the Wood River Lakes amounted to 675,200 and was 61.4 percent of the total Nushagak district escapement.

4. Three areas, Agulowak River, Lake Nerka and Agulukpak River, accounted for over 70 percent of the estimated escapement.

5. Large returns to the Agulowak and Agulukpak Rivers and small returns to the spawning creeks and beaches resulted in an increase in percent of river spawning and a decline in percent of creek and beach spawning over 1964.

6. Peak aerial estimates in the Wood River Lakes accounted for 64.6 percent of the total escapement.

7. Red salmon escapement to the Igushik Lakes system was 180,800, which was 16.5 percent of the total Nushagak district escapement.

8. Percent of fish accounted for by peak aerial surveys was 44.5 percent which compares closely with past years.

9. Only 1.1 percent of 12,000 red salmon of the Nushagak district escapement entered Lake Nunavaugaluk (Snake River system).

10. The escapement of 203,100 red salmon to the Tikchik Lakes system was 18.5 percent of the total Nushagak district escapement.

11. Percent of fish accounted for by peak aerial surveys in the Tikchik system was 46.7 percent.

12. The Nushagak-Mulchatna River system accounted for 2.6 percent of the Nushagak district escapement.

13. Escapement of red salmon to the Togiak Lakes amounted to 88,400 or was 78.4 percent of the district total.

14. The Togiak tributaries accounted for only 7.2 percent of the district red salmon escapement.

15. A record escapement of 16,300 red salmon in the Kulukak Lake system accounted for 14.5 percent of the total Togiak district escapement.

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APPENDIX

Table 1. Comparison of peak red salmon spawning ground estimates in the
Wood River Lakes, 1964-65.

| Area | 1964 | | 1965 | | Ratio |
	Date	No. Est.	Date	No. Est.	1965/1964
		WOOD RIVER LAKES			
Wood River	8/12	11,300	8/30	2,960	.26
LAKE ALEKNAGIK:					
Mission Creek	8/12	100	8/13	130	
Eagle Creek		–	8/23	500	
Hansen Creek	8/12	2,600	8/ 1	3,620	
Happy Creek	8/12	1,700	8/ 6	2,470	
Bear Creek	8/12	2,400	8/ 5	3,650	
Yako Creek	8/12	1,100	8/ 1	920	
Whitefish Creek	8/12	1,100	8/23	200	
Whitefish Creek Lake		–	8/23	200	
Ice Creek	8/12	4,800	8/10	11,300	
Sunshine Creek	8/12	800	8/23	490	
Northshore Creeks	8/12	4,720	8/23	60	
Northshore Beaches	8/12	4,300	8/30	2,690	
Southshore Beaches	8/12	1,800	8/30	1,020	
Yako Beach	8/12	500	8/30	100	
LAKE ALEKNAGIK TOTAL		25,920		27,350	1.06
Agulowak River and Lower River Bay	8/28	42,400	8/30	140,000	3.30
LAKE NERKA:					
Fenno Creek	8/16	3,060	8/14	1,620	
Upper River Bay, N.W.	8/28	2,800	8/23	400	
Upper River Bay, S.E.	8/28	5,700	8/30	3,500	
Allah Creek Beach	8/13	5,300	8/30	1,990	
Ross Creek-Pike Creek	8/13	500	8/30	0	
Pike Creek	8/13	3,400		2,000	
Stovall Creek	8/13	11,300	8/22	2,590	
Stovall Lake		–	8/23	200	
Bear Creek	8/13	1,800	8/23	400	
Bear Creek Lakes		–	8/23	100	
Teal Creek	8/13	2,400	8/23	40	
River Bay – N4 Beach	8/24	1,800	8/30	540	
N4-N6 Beach	8/24	10,000	8/30	6,370	
Pick Creek Beach	8/24	8,700	8/30	1,110	

Table 1. (Continued)

| Area | 1964 | | 1965 | | Ratio |
	Date	No. Est.	Date	No. Est.	1965/1964
Pick Creek	8/15	12,400	8/15	7,500	
Elva Creek Beach	8/15	1,600	8/23	1,100	
Elva Creek	8/15	700	8/23	100	
Amakuk Arm	8/28	1,900	8/30	860	
Amakuk Arm-Ott's Bay	8/24	4,400	8/30	220	
Ott's Bay	8/15	1,700	8/30	900	
Ott's Bay-Agulukpak R.	8/24	3,000	8/30	0	
Kema Creek	8/25	3,460	8/21	3,230	
Kema Creek Lake		–	8/23	0	
Hidden Lake Creek	8/18	7,830	8/20	990	
Hidden Lake		–	8/23	800	
Anvil Bay	8/28	32,800	8/30	12,910	
Anvil Bay-Elbow Pt.	8/28	9,100	8/23	2,970	
Elbow Pt.-Lynx Creek	8/20	5,800	8/30	1,960	
Lynx Creek	8/13	2,100	8/23	900	
Lynx Lake	8/13	4,500	8/30	7,500	
Lynx Creek-Teal Creek		–	8/30	210	
LAKE NERKA TOTAL		148,050		63,010	.43
Little Togiak River	8/15	15,000	8/23	8,000	.53
LITTLE TOGIAK LAKE:					
A Creek	8/17	170	8/19	10	
B Creek	8/17	0	8/19	0	
C Creek	8/17	440	8/19	170	
Little Togiak Creek	8/24	1,400	8/23	700	
Northshore Beaches	8/24	2,500	8/23	3,260	
Southshore Beaches	8/24	5,800	8/30	2,120	
D Slough Beach	9/15	4,900	8/30	15,000	
LITTLE TOGIAK LAKE TOTAL		15,210		21,260	1.40
Agulukpak River	8/24	38,900	8/30	120,000	3.08
LAKE BEVERLY:					
Hardluck Bay	8/24	25,400	8/30	15,350	
Sam's Beach	8/21	300	8/30	550	
Golden Horn	8/21	2,200	8/30	860	
Silver Horn	8/24	69,500	8/30	4,440	
B-12 Beach	8/24	9,900	8/30	1,300	
B-9 Beach	8/24	1,000	8/30	40	

Table 1. (Continued)

| Area | 1964 | | 1965 | | Ratio |
	Date	No. Est.	Date	No. Est.	1965/1964
Anniversary Bay	8/24	500	8/30	0	
Tsun Creek	8/21	2,600	8/30	1,100	
Moose Creek	8/19	12,660	8/18	1,660	
Hope Creek	8/14	15,000	8/23	200	
Hope Creek Lake		–	8/23	200	
Miscellaneous		1,300		80	
LAKE BEVERLY TOTAL		140,360		25,780	.18
Peace River	8/21	16,800	8/21	5,300	.32
LAKE MIKCHALK:					
Narrows	8/21	–	8/23	2,000	
Northshore Beaches	8/21	–	8/30	30	
Southshore Beaches	8/21	–	8/30	5,000	
LAKE MIKCHALK TOTAL		9,500		7,030	.74
Wind River	9/ 5	3,600	8/21	1,800	.50
LAKE KULIK:					
K-5 Creek–Grant River	9/ 5	16,800	8/30	70	
Grant River–K-11 Creek	9/ 5	0	8/30	250	
K-11 Creek–K-10 Creek	9/ 5	0	8/30	1,430	
K-10 Creek–K-4 Creek	9/ 5	18,700	8/30	1,860	
K-4 Creek–K-2 Creek	9/ 5	14,400	8/30	1,120	
Southshore Beaches	9/ 5	1,100	8/30	1,410	
K-1 Creek		–	8/23	1,700	
K-2 Creek		–	8/23	100	
LAKE KULIK TOTAL		51,000		7,940	.16
Grant River	8/22	18,400	8/21	5,400	.29
WOOD RIVER LAKES TOTAL		536,440		435,830	

Figure 1.--Spawning distribution in the Wood
River Lakes system, Bristol Bay, Alaska, 1965.

Table 2. Comparison of peak red salmon spawning ground estimates in
the Igushik Lakes, 1964-65.

| Area | 1964 | | 1965 | | Ratio |
	Date	No. Est.	Date	No. Est.	1965/1964
IGUSHIK LAKES					
Igushik River	8/11	50		200	4.00
LAKE AMANKA:					
Longarm Creek	8/11	600	8/17	2,600	
Middle Creek	8/11	50	8/17	200	
South Creek	8/11	1,300	8/17	160	
Amanka Beaches	8/11	1,150	8/17	1,120	
LAKE AMANKA TOTAL		3,100		4,080	1.32
KATHLENE RIVER:					
Lower River	8/11	9,000	8/17	6,400	
Upper River	8/11	11,000	8/17	7,600	
Ongoke River	8/11	7,800	8/17	7,100	
KATHLENE RIVER TOTAL		27,800		21,100	.76
LAKE UALIK:					
Frances Creek	8/11	4,000	8/17	6,300	
Westshore Creeks	8/11	2,500	8/17	1,800	
Westshore Beaches	8/11	20,000	8/27	40,000	
Eastshore Creeks	8/11	100	8/17	420	
Eastshore Beaches	8/11	1,700	8/17	6,600	
LAKE UALIK TOTAL		28,300		55,120	1.95
IGUSHIK LAKES TOTAL		59,250		80,500	

LAKE UALIK

FRANCIS CR.

KATHLENE

REDLEAF CR.

ONGOKE RIVER

IGUSHIK R.

LONGARM CREEK

AMANKA LAKE

SOUTH CR.

MIDDLE CR.

N

Indicates spawning
distribution

Figure 2.--Spawning distribution in the Igushik Lakes
system, Bristol Bay, Alaska, 1965.

Table 3. Comparison of peak red salmon spawning ground estimates in Lake
Nunavaugaluk and the Nushagak-Mulchatna System, 1964-65.

| Area | 1964 | | 1965 | | Ratio |
	Date	No. Est.	Date	No. Est.	1965/1964
LAKE NUNAVAUGALUK					
Snake River	8/11	50	8/17	200	4.00
LAKE NUNAVAUGALUK:					
Snake River-Eagle Creek	8/11	1,500	9/11	1,660	
Eagle Creek	8/11	50	8/17	60	
Eagle Creek Lake	8/11	–	8/17	120	
Westshore Beaches	8/11	3,000	9/11	2,550	
Killian Creek	8/11	1,500	8/17	1,600	
Eastshore Beaches	8/11	1,300	9/11	890	
East Creek	8/11	100	8/17	100	
Southshore Beaches	8/11	400	8/17	500	
LAKE NUNAVAUGALUK TOTAL		7,850		7,480	.95
LAKE NUNAVAUGALUK SYSTEM TOTAL		7,900		7,680	
NUSHAGAK-MULCHATNA SYSTEM					
NUSHAGAK SYSTEM:					
Nushagak River	8/ 2	2,600	8/17	6,200	2.38
Iowithla River	8/15	(200)		–	
Kokwok River		–	8/23	(250)	
Okstukuk Lakes	8/15	1,100	8/23	2,380	2.16
King Salmon River	8/ 2	200	7/30	1,000	5.00
NUSHAGAK SYSTEM TOTAL		4,100		9,680	
MULCHATNA SYSTEM:					
Mulchatna River	8/14	4,700	8/27	4,840	1.03
Koktuli River	8/14	800	8/27	300	.38
Stuyohok River	8/ 5	(100)		–	
Chilchitna River	8/14	(100)		–	
MULCHATNA SYSTEM TOTAL		5,500		5,140	
NUSHAGAK-MULCHATNA TOTAL		9,600		14,820	

(Note: Figures in parentheses not included in totals used for computing 1965/64
ratios.)

KILLIAN CR.

N

LAKE NUNAVAGALUK

EAGLE CR.

EAST CR.

SNAKE R.

0   5

Scale in Miles

Indicates spawning
distribution

Figure 3.--Spawning distribution in the
Lake Nunavagaluk system, Bristol Bay,
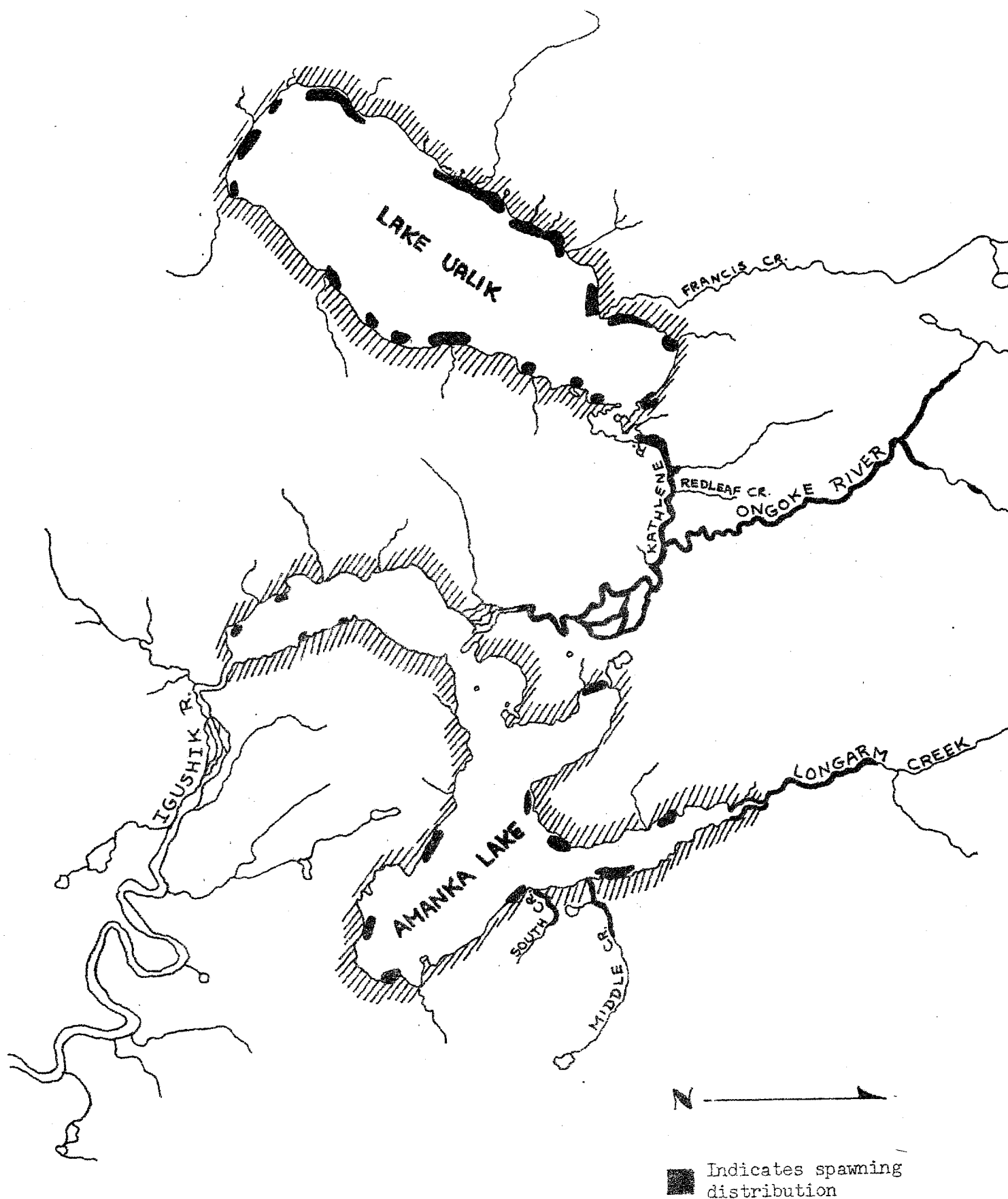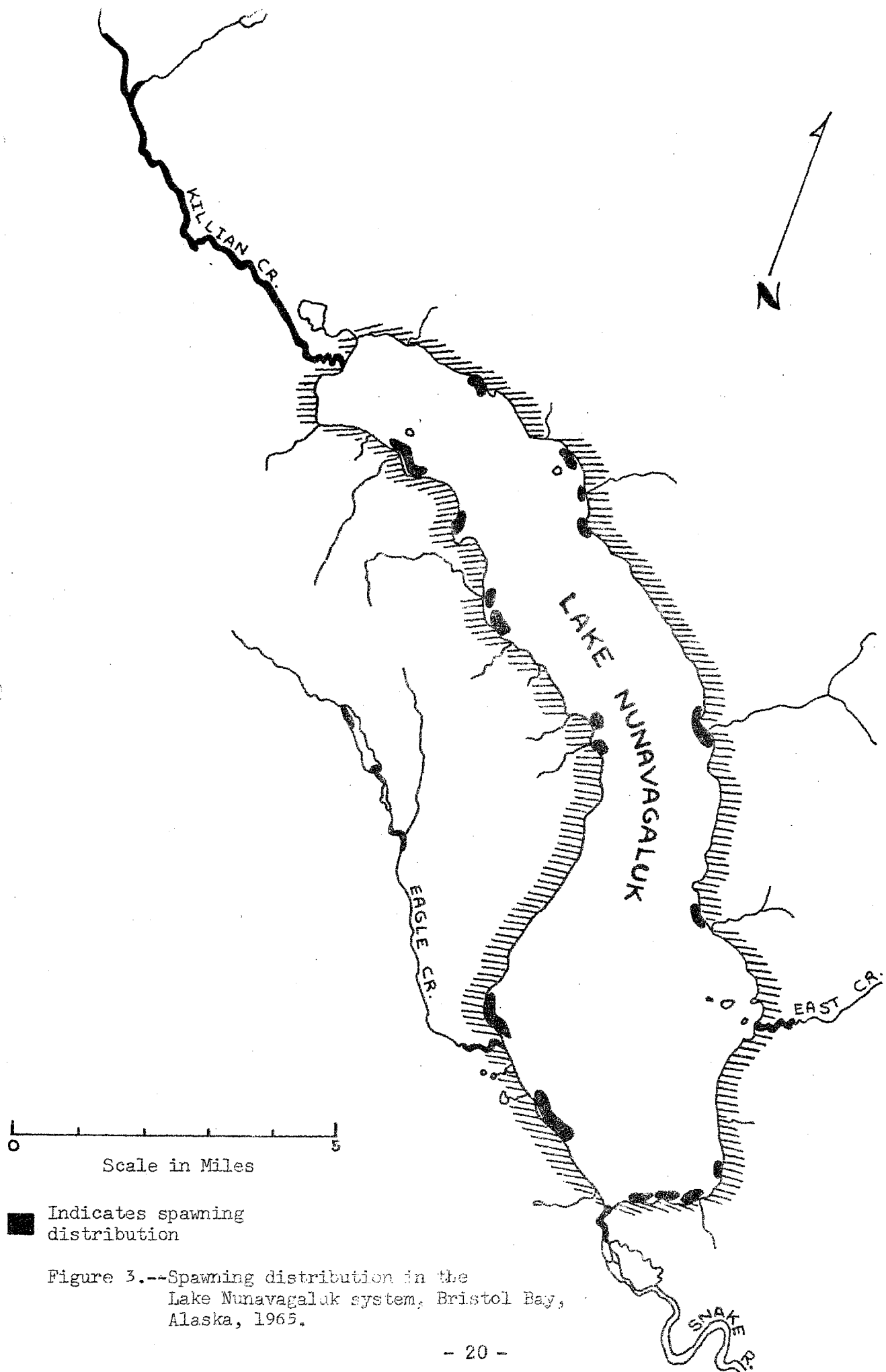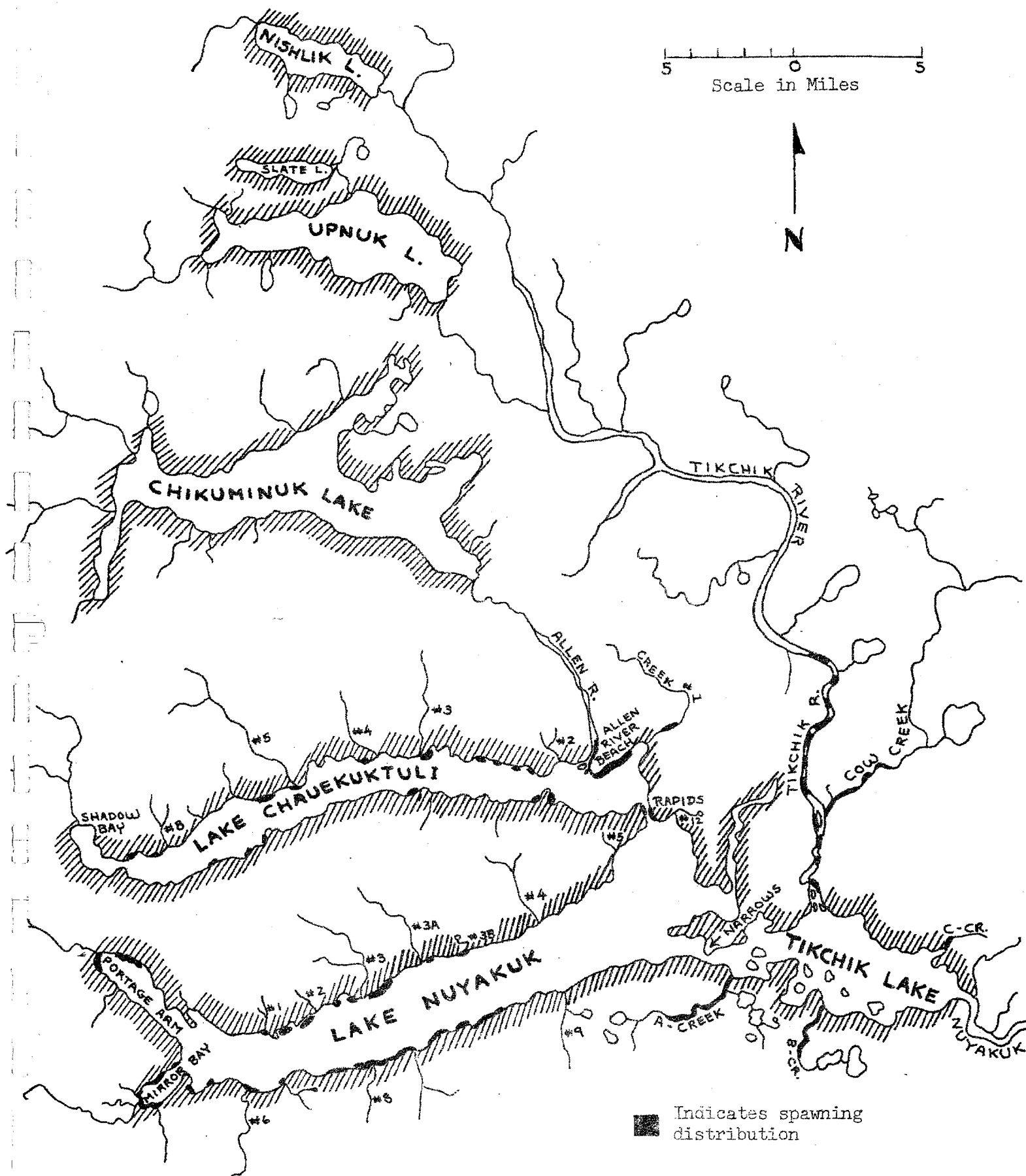Alaska, 1965.

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Figure 4.--Spawning distribution in the Tikchik Lakes system,
Bristol Bay, Alaska, 1965.

Table 4. Comparison of peak red salmon spawning ground estimates to the
Tikchik Lakes, 1964-65.

Area	1964		1965		Ratio 1965/1964
	Date	No. Est.	Date	No. Est.	
TIKCHIK LAKES					
Nuyakuk River	8/24	100	8/28	(400)	4.00
TIKCHIK LAKE:					
Creek A	8/21	800	8/21	360	
Creek B	8/24	2,000	8/21	10,000	
Creek C	8/24	30	8/21	200	
TIKCHIK LAKE TOTAL		2,830		10,560	3.73
Tikchik River	8/10	2,750	8/21	15,000	5.45
NUYAKUK LAKE:					
Northshore Beaches	9/ 6	6,600	8/28	4,510	
Southshore Beaches	9/ 6	7,100	8/28	13,320	
Portage Arm	9/ 6	1,100	8/28	1,180	
Mirror Bay	9/ 6	2,300	8/28	19,600	
Rapids	8/11	600	8/21	750	
NUYAKUK LAKE TOTAL		17,700		39,360	2.22
LAKE CHAUEKUKTULI:					
Creek No. 1	8/24	50	8/21	100	
Allen River Beach	8/10	20,500	8/28	24,500	
Allen River	8/11	250	8/21	320	
Northshore Beaches	8/24	6,400	8/28	4,640	
Southshore Beaches	8/24	900	8/28	310	
LAKE CHAUEKUKTULI TOTAL		28,100		29,870	1.06
TIKCHIK LAKES TOTAL		51,480		94,790	

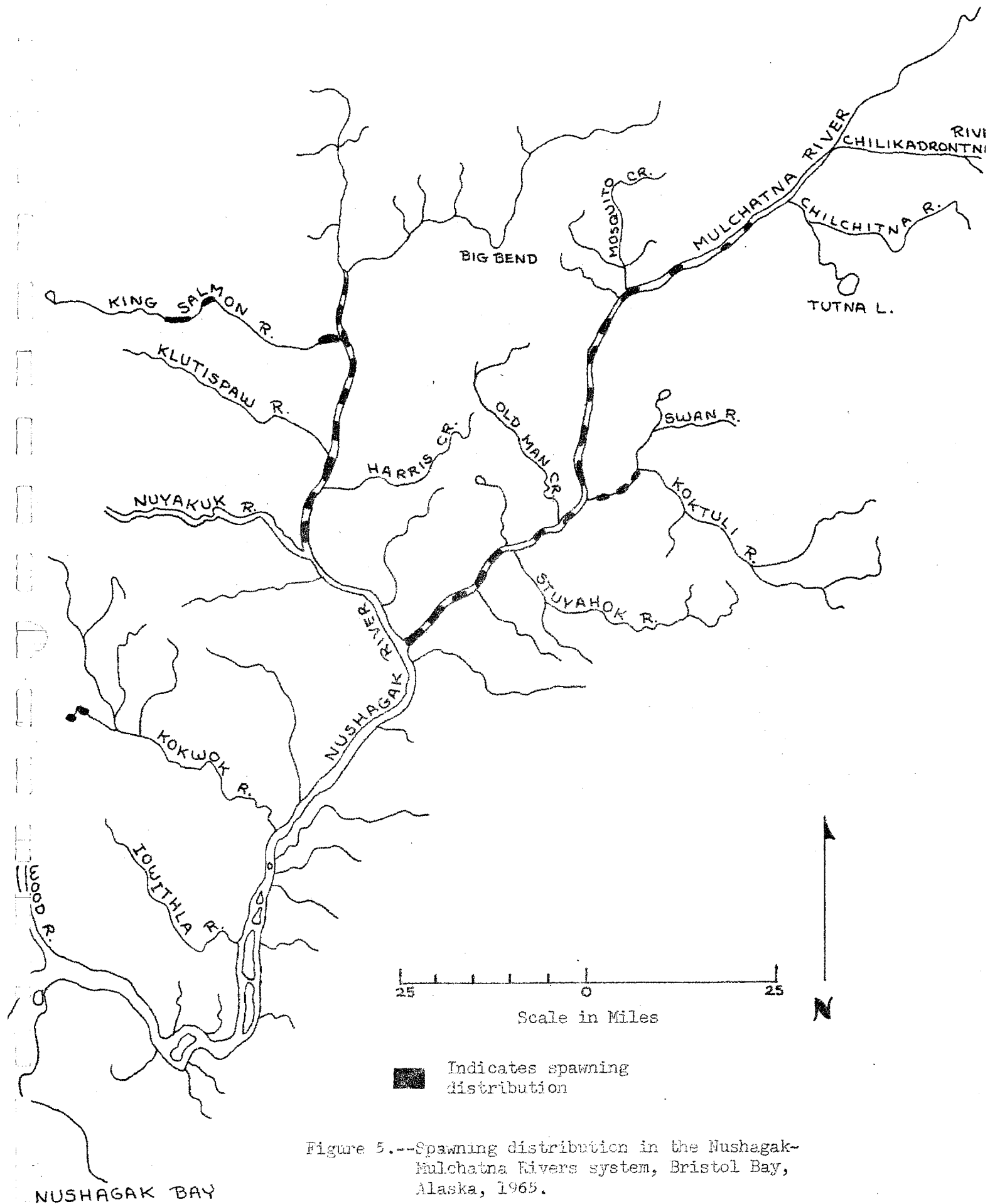(Note: Figures in parentheses not included in totals used for computing 1965/64
ratios.)

Figure 5.--Spawning distribution in the Nushagak-
Mulchatna Rivers system, Bristol Bay,
Alaska, 1965.

Table 5. Comparison of peak red salmon spawning ground estimate in the Togiak district, 1964-65.

| | 1964 | | 1965 | | Ratio |
Area	Date	No. Est.	Date	No. Est.	1965/1964
	TOGIAK LAKES				
Togiak River	9/ 3	300	8/20	160	.53
TOGIAK LAKE:					
Outlet-Jondik Creek	9/ 3	1,300		700	
Jondik Creek	9/ 3	800	8/20	1,550	
Jondik Creek-Bruin Cr.	9/ 3	4,200		4,000	
Bruin Creek-Middle Pt.	9/ 3	2,500		1,500	
Middle Pt.-Sunday Creek	9/ 3	15,000		15,000	
Northshore Beaches	9/ 3	3,000		2,000	
Westshore Beaches	9/ 3	3,300		1,500	
West Creek	9/ 3	100	8/24	500	
West Lake	9/ 3	-	8/24	200	
TOGIAK LAKE TOTAL		30,200		26,950	.89
Zwischen River	9/ 3	3,000	8/20	10,470	3.49
UPPER TOGIAK LAKE:					
Zwischen R.-Budole Cr.	9/ 3	5,000		2,500	
Budole Cr.-Upper Togiak Creek	9/ 3	5,500		2,000	
Northshore Beaches	9/ 3	2,500		500	
Makoo Creek	9/ 3	400		100	
Upper Togiak Creek	9/ 3	200		200	
Westshore Beaches	9/ 3	600		250	
UPPER TOGIAK LAKE TOTAL		14,200		5,550	.39
TOGIAK LAKES TOTAL		47,700		43,130	
	TOGIAK TRIBUTARIES				
TOGIAK TRIBUTARIES:					
Gechiak Lake	7/27	600	8/24	1,780	2.97
Ongivinuk Lake	8/11	2,500	8/20	1,600	.64
Pungokepuk Lake	7/27	200	8/20	290	1.45
Miscellaneous		800		-	
TOGIAK TRIBUTARIES TOTAL		4,100		3,770	

Table 5. (Continued)

| Area | 1964 | | 1965 | | Ratio |
	Date	No. Est.	Date	No. Est.	1965/1964
KULUKAK RIVER SYSTEM					
KULUKAK RIVER SYSTEM:					
Kulukak River	7/29	2,800	8/20	950	.60
Kulukak Lake	7/29		8/20	730	
Tithe Creek Ponds	8/11	1,600	8/20	5,600	3.50
KULUKAK SYSTEM TOTAL		4,400		7,280	

Scale in Miles

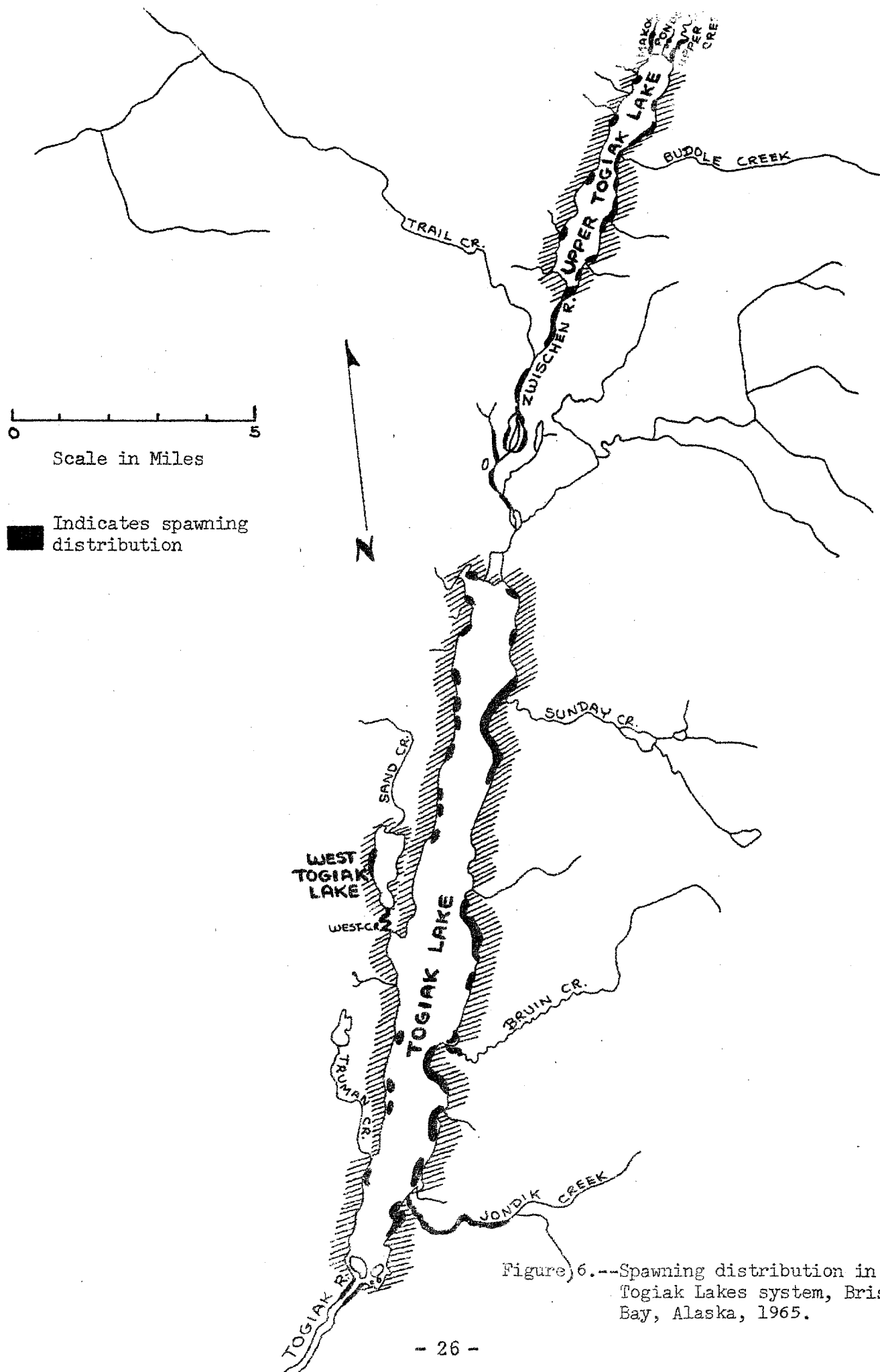■ Indicates spawning distribution

Figure 6.--Spawning distribution in the Togiak Lakes system, Bristol Bay, Alaska, 1965.

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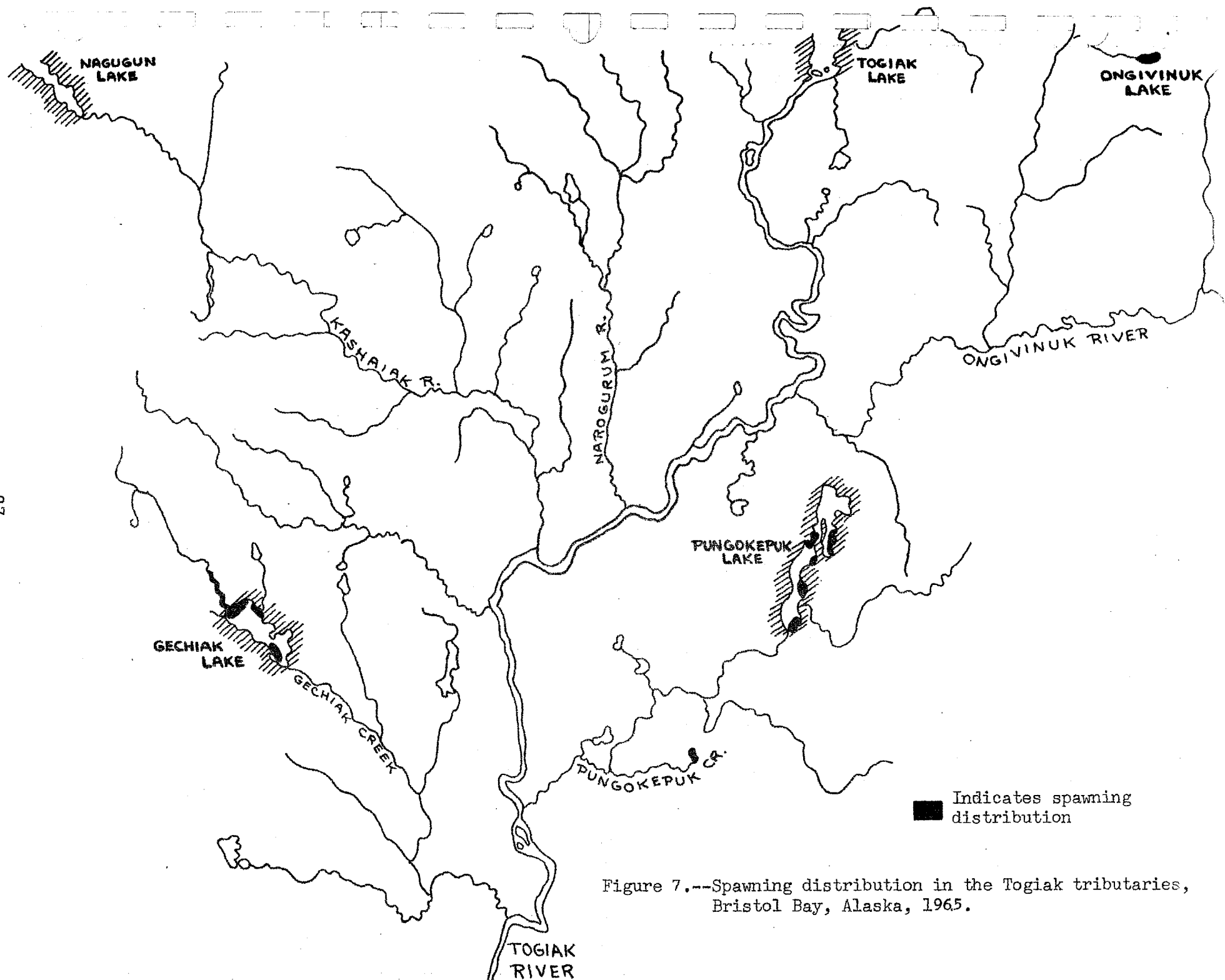
Figure 7.—Spawning distribution in the Togiak tributaries, Bristol Bay, Alaska, 1965.
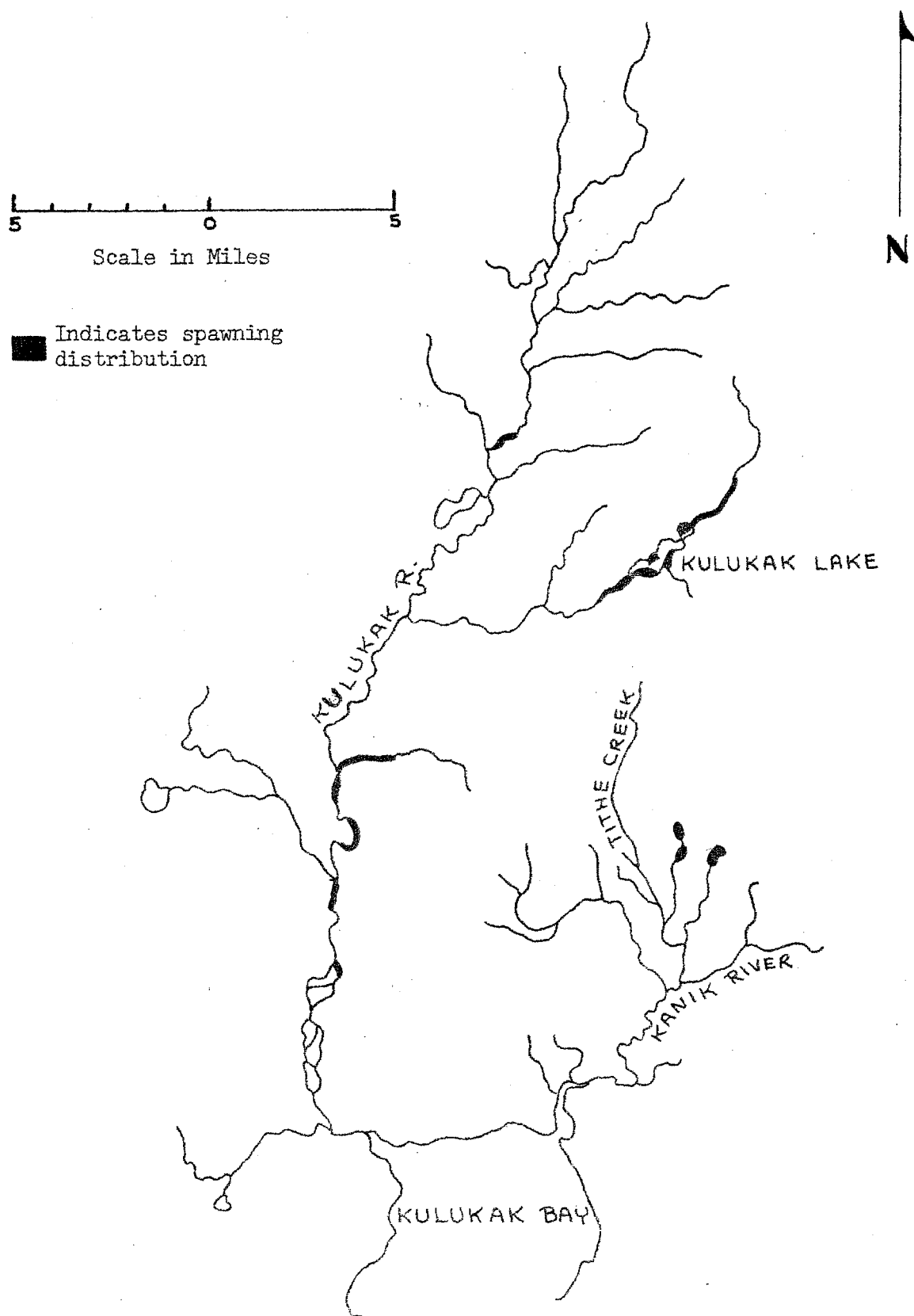
Indicates spawning distribution

Figure 8.—Spawning distribution in the Kulukak Lake system,
Bristol Bay, Alaska, 1965.

Table 6. Total population estimates of red salmon in the Nushagak district, 1964-65.

Area	Total Pop. Adj. Est.	Ratio 1965/1964	1965 Preliminary Estimate	1965 Total Pop. Adj. Est.	Percent of Total Pop. Adj. Est.	Percent of Nushagak district Total
			WOOD RIVER LAKES			
Wood River	19,000	.26	4,940	5,400	.80	.49
Lake Aleknagik	46,000	1.06	48,760	49,200	7.29	4.48
Agulowak River	50,100	3.30	165,330	165,000	24.44	15.01
Lake Nerka	384,700	.43	165,421	176,000	26.08	16.02
Little Togiak River	26,000	.53	13,780	14,000	2.07	1.27
Little Togiak Lake	19,500	1.40	27,300	26,500	3.92	2.41
Agulukpak River	42,900	3.08	132,132	130,800	19.37	11.90
Lake Beverly	317,300	.18	57,114	60,600	8.98	5.51
Peace River	18,800	.32	6,016	6,600	.98	.60
Lake Mikchalk	13,000	.74	9,620	10,500	1.55	.96
Wind River	4,500	.50	2,250	2,500	.37	.23
Lake Kulik	111,600	.16	17,856	19,700	2.92	1.79
Grant River	22,700	.29	6,583	8,300	1.23	.76
WOOD RIVER LAKES TOTAL	1,076,100		657,102	675,200	100.00	61.43
			IGUSHIK LAKES			
Igushik River	100	4.00	400	400	.22	.04
Lake Amanka	6,500	1.32	8,580	10,000	5.53	.91
Kathlene River	60,400	.76	45,904	48,600	26.88	4.42
Lake Ualik	61,500	1.95	119,925	121,800	67.37	11.08
IGUSHIK LAKES TOTAL	128,500		174,809	180,800	100.00	16.45
			LAKE NUNAVAUGALUK			
Snake River	100	4.00	400	300	2.50	.03
Lake Nunavaugaluk	12,300	.95	11,685	11,700	97.50	1.06
LAKE NUNAVAUGALUK TOT.	12,400		12,085	12,000	100.00	1.09

Table 6. (Continued)

Area	Total Pop. Adj. Est.	Ratio 1965/1964	1965 Preliminary Estimate	1965 Total Pop. Adj. Est.	Percent of Total Pop. Adj. Est.	Percent of Nushagak district Total
			TIKCHIK LAKES			
Tikchik Lake	7,200	3.73	26,856	27,300	13.44	2.48
Tikchik River	5,000	5.45	27,250	26,200	12.90	2.38
Nuyakuk Lake	36,400	2.22	80,808	88,800	43.72	8.08
Lake Chauekuktuli	54,600	1.06	57,876	60,800	29.94	5.53
TIKCHIK LAKES TOTAL	103,200		192,790	203,100	100.00	18.47
			NUSHAGAK-MULCHATNA SYSTEM			
Nushagak River	5,000	2.38	11,900	11,900	66.48	1.08
Iowithla River	400	-	-	-	-	-
Okstukuk Lakes	2,100	2.16	4,536	4,600	25.70	.42
King Salmon River	200	5.00	1,000	1,400	7.82	.13
NUSHAGAK SYSTEM TOTAL	7,700		17,436	17,900	100.00	1.63
Mulchatna River	9,400	1.03	9,682	9,700	94.17	.88
Koktuli River	1,600	.38	608	600	5.83	.05
MULCHATNA SYSTEM TOTAL	11,000		10,290	10,300	100.00	.93
NUSHAGAK-MULCHATNA SYSTEM TOTAL	18,700		27,726	28,200		2.56
NUSHAGAK DISTRICT TOTAL	1,338,900		1,021,382	1,099,300		100.00

Table 7. Total population estimates of red salmon in the Togiak district, 1964-65.

Area	Total Pop. Adj. Est.	Ratio 1965/1964	1965 Preliminary Estimate	1965 Total Pop. Adj. Est.	Percent of Total Pop. Adj. Est.	Percent of Togiak district Total
TOGIAK LAKES						
Togiak River	400	.53	318	300	.34	.27
Togiak Lake	60,100	.89	53,890	54,300	61.42	48.14
Zwischen River	6,500	3.49	22,685	22,700	25.68	20.12
Upper Togiak Lake	28,400	.39	11,076	11,100	12.56	9.84
TOGIAK LAKES TOTAL	95,600		87,969	88,400	100.00	78.37
TOGIAK TRIBUTARIES						
Gechiak Lake	1,400	2.97	4,158	4,100	50.62	3.63
Ongivinuk Lake	5,600	.64	3,584	3,300	40.74	2.92
Pungokepuk Lake	500	1.45	725	700	8.64	.62
Miscellaneous	1,800	-	-	-	-	-
TOGIAK TRIBUTARIES TOTAL	9,300		8,467	8,100	100.00	7.17
KULUKAK SYSTEM						
Kulukak River)	6,200	.60	3,720	1,800	11.04	1.60
Kulukak Lake)				1,800	11.04	1.60
Tithe Creek Ponds	3,600	3.50	12,600	12,700	77.92	11.26
KULUKAK SYSTEM TOTAL	9,800		16,320	16,300	100.00	14.46
TOGIAK DISTRICT TOTAL	114,700		112,756	112,800		100.00

Table 8. Comparison of total population estimates of red salmon
and total population estimates derived by the chain-link
index in the Nushagak and Togiak districts, 1960-65.

Year	Total Pop. Est. by Tower Count	Est. Total Pop. by Chain-Link Index	Error No. of Fish	Percent
		WOOD RIVER LAKES		
1960	1,016,100	1,063,873	+ 47,773	+ 4.5
1961	460,700	451,774	- 8,926	- 1.9
1962	873,900	937,304	+ 63,404	+ 6.8
1963	721,400	752,265	+ 30,865	+ 4.1
1964	1,076,100	1,024,410	- 51,690	- 4.8
1965	675,200	657,102	- 18,098	- 2.7
			Average	1.0
		IGUSHIK LAKES		
1960	495,100	515,538	+ 20,438	+ 4.0
1961	294,300	265,112	- 29,188	- 9.9
1962	15,700	17,955	+ 2,255	+12.6
1963	92,200	89,319	- 2,881	- 3.1
1964	128,500	125,578	- 2,922	- 2.3
1965	180,800	174,809	- 5,991	- 3.3
			Average	- .3
		LAKE NUNAVAUGALUK		
1960	16,600	16,182	- 418	- 2.5
1961	4,900	5,270	+ 370	+ 7.0
1962	1,800	1,738	- 62	- 3.4
1963	38,000	33,602	- 4,398	-11.6
1964	12,400	17,350	+ 4,950	+28.5
			Average	3.6
		TIKCHIK LAKES		
1960	145,500	150,241	+ 4,741	+ 3.1
1961	79,800	87,730	+ 7,930	+ 9.0
1962	37,900	45,263	+ 7,363	+16.3
1963	166,600	225,194	+58,594	+26.0
1964	103,200	102,095	- 1,105	- 1.1
1965	203,100	192,790	-10,310	- 5.1
			Average	- 8.0

Table 8. (Continued)

Year	Total Pop. Est. by Tower Count	Est. Total Pop. by Chain-Link Index	Error No. of Fish	Error Percent

TOGIAK LAKES

Year	Total Pop. Est. by Tower Count	Est. Total Pop. by Chain-Link Index	No. of Fish	Percent
1961	95,500	104,879	+ 9,379	+ 8.9
1962	47,400	47,160	− 240	− .5
1963	102,400	116,059	+13,659	+11.8
1964	95,600	95,189	− 411	− .4
1965	88,400	87,969	− 431	− .5
			Average	3.9

TOTAL

Year	Total Pop. Est. by Tower Count	Est. Total Pop. by Chain-Link Index	No. of Fish	Percent
1960	1,673,300	1,745,834	+72,534	+ 4.2
1961	935,200	914,765	− 20,435	− 2.2
1962	976,700	1,049,420	+72,720	+ 6.9
1963	1,120,600	1,216,439	+95,839	+ 7.9
1964	1,415,800	1,364,622	−51,178	− 3.6
1965	1,147,500	1,112,670	−34,830	− 3.0
			Average	1.7

Table 9. Comparison of total population estimates and percent of red salmon by area in the Nushagak district, 1961-65.

Area	1961 Pop.Est.	1961 Percent	1962 Pop.Est.	1962 Percent	1963 Pop.Est.	1963 Percent	1964 Pop.Est.	1964 Percent	1965 Pop.Est.	1965 Percent	Geo.Mean % By Area 1961-65

WOOD RIVER LAKES

Area	1961 Pop.Est.	1961 Percent	1962 Pop.Est.	1962 Percent	1963 Pop.Est.	1963 Percent	1964 Pop.Est.	1964 Percent	1965 Pop.Est.	1965 Percent	Geo.Mean % By Area 1961-65
Wood River	7,300	1.59	2,600	.30	800	.11	19,000	1.76	5,400	.80	.59
Lake Aleknagik	19,000	4.12	26,200	3.00	15,700	2.18	46,000	4.27	49,200	7.29	3.85
Agulowak River	127,200	27.61	20,200	2.31	14,200	1.97	50,100	4.65	165,000	24.44	6.78
Lake Nerka	134,200	29.13	261,500	29.88	167,900	23.27	384,700	35.75	176,100	26.08	28.58
Little Togiak R.	5,000	1.09	5,000	.57	15,000	2.08	26,000	2.42	14,000	2.07	1.45
Little Togiak Lake	10,500	2.28	9,700	1.11	21,100	2.93	19,500	1.81	26,500	3.92	2.21
Agulukpak River	101,600	22.05	31,300	3.58	47,500	6.58	42,900	3.99	130,800	19.37	8.34
Lake Beverly	29,100	6.32	376,000	43.02	251,500	34.86	317,300	29.49	60,600	8.98	19.05
Peace River	800	.17	14,900	1.70	19,300	2.68	18,800	1.75	6,600	.98	1.06
Lake Mikchalk	3,200	.70	35,900	4.11	19,400	2.69	13,000	1.21	10,500	1.55	1.71
Wind River	2,000	.43	7,600	.87	5,000	.69	4,500	.42	2,500	.37	.53
Lake Kulik	9,500	2.06	71,900	8.23	111,100	15.40	111,600	10.37	19,700	2.92	6.31
Grant River	11,300	2.45	11,500	1.32	32,900	4.56	22,700	2.11	8,300	1.23	2.08
WOOD RIVER LAKES TOTAL	460,700	100.00	873,900	100.00	721,400	100.00	1,076,100	100.00	675,200	100.00	

IGUSHIK LAKES

Area	1961 Pop.Est.	1961 Percent	1962 Pop.Est.	1962 Percent	1963 Pop.Est.	1963 Percent	1964 Pop.Est.	1964 Percent	1965 Pop.Est.	1965 Percent	Geo.Mean % By Area 1961-65
Igushik River	–	–	300	1.91	80	.09	100	.08	400	.22	.74
Lake Amanka	16,100	5.47	1,100	7.01	3,510	3.81	6,500	5.06	10,000	5.53	5.26
Kathlene River	124,100	42.18	7,600	48.41	46,100	50.00	60,400	47.00	48,600	26.88	41.78
Lake Ualik	154,000	52.35	6,700	42.67	42,510	46.10	61,500	47.86	121,800	67.37	50.58
IGUSHIK LAKES TOTAL	294,200	100.00	15,700	100.00	92,200	100.00	128,500	100.00	180,800	100.00	

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Table 9 (Continued)

Area	1961 Pop.Est.	Percent	1962 Pop.Est.	Percent	1963 Pop.Est.	Percent	1964 Pop.Est.	Percent	1965 Pop.Est.	Percent	Geo.Mean % By Area 1961-65
				LAKE NUNAVAUGALUK							
Snake River	200	4.08	150	8.33	500	1.32	100	.81	300	2.50	2.46
Lake Nunavaugaluk	4,700	95.92	1,650	91.67	37,500	98.68	12,300	99.19	11,700	97.50	96.61
LAKE NUNA. TOTAL	4,900	100.00	1,800	100.00	38,000	100.00	12,400	100.00	12,000	100.00	
				TIKCHIK LAKES							
Tikchik Lake	6,700	8.40	3,100	8.18	32,500	19.51	7,200	6.98	27,300	13.44	15.49
Tikchik River	29,700	37.22	4,500	11.87	80,400	48.26	5,000	4.84	26,200	12.90	16.79
Nuyakuk Lake	8,500	10.65	7,500	19.79	6,100	3.66	36,400	35.27	88,800	43.72	16.44
Lake Chauekuktuli	34,900	43.73	22,800	60.16	47,600	28.57	54,600	52.91	60,800	29.94	41.02
TIKCHIK LAKES TOT.	79,800	100.00	37,900	100.00	166,600	100.00	103,200	100.00	203,100	100.00	
				NUSHAGAK-MULCHATNA SYSTEM							
Nushagak River	800	6.25	600	22.22	2,100	6.03	5,000	64.94	11,900	66.48	20.51
Iowithla River	3,000	23.44	400	14.82	1,900	5.46	400	5.19	–	–	9.95
Okstukuk Lakes	–	–	1,100	40.74	30,000	86.21	2,100	27.27	4,600	25.70	39.63
King Salmon River	9,000	70.31	600	22.22	800	2.30	200	2.60	1,400	7.82	9.40
NUSHAGAK SYSTEM TOTAL	12,800	100.00	2,700	100.00	34,800	100.00	7,700	100.00	17,900	100.00	
Mulchatna River	3,800	51.35	3,500	60.34	6,600	60.55	9,400	85.45	9,700	94.17	68.55
Koktuli River	3,600	48.65	2,300	39.66	4,300	39.45	1,600	14.54	600	5.83	23.01
MULCHATNA TOTAL	7,400	100.00	5,800	100.00	10,900	100.00	11,000	100.00	10,300	100.00	
NUSH.-MULCH. TOTAL	20,200		8,500		45,700		18,700		28,200		
NUSHAGAK DIST. TOTAL	859,800		937,800		1,063,900		1,338,900		1,099,300		

Table 10. Comparison of total population estimates and percent of red salmon by area in the Togiak district, 1961-65.

Area	1961 Pop.Est.	1961 Percent	1962 Pop.Est.	1962 Percent	1963 Pop.Est.	1963 Percent	1964 Pop.Est.	1964 Percent	1965 Pop.Est.	1965 Percent	Geo.Mean By Area 1961-65
TOGIAK LAKES											
Togiak River	1,900	1.99	400	.84	400	.39	600	.63	300	.34	.67
Togiak Lake	73,400	76.86	17,000	35.87	55,100	53.81	60,100	62.86	54,300	61.42	56.75
Zwischen River	11,600	12.15	15,700	33.12	11,500	11.23	6,500	6.80	22,700	25.68	15.14
Upper Togiak Lake	8,600	9.00	14,300	30.17	35,400	34.57	28,400	29.71	11,100	12.56	20.37
TOGIAK LAKES TOTAL	95,500	100.00	47,400	100.00	102,400	100.00	95,600	100.00	88,400	100.00	
TOGIAK TRIBUTARIES											
Gechiak Lake	16,800	62.69	11,400	79.45	5,900	42.75	1,400	15.05	4,100	50.62	43.85
Ongivinuk Lake	8,400	31.34	2,000	13.70	6,000	43.48	5,600	60.22	3,300	40.74	34.04
Pungokepuk Lake	900	3.36	600	4.11	1,500	10.87	500	5.38	700	8.64	5.88
Miscellaneous	700	2.61	400	2.74	400	2.90	1,800	19.35	-	-	4.48
TOGIAK TRIB. TOTAL	26,800	100.00	14,600	100.00	13,800	100.00	9,300	100.00	8,100	100.00	
KULUKAK SYSTEM											
Kulukak River 1/	1,000	19.23	4,900	51.04	4,800	42.11	6,200	63.64	1,800	11.04	31.05
Kulukak Lake	-	-	-	-	-	-	-	-	1,800	11.04	-
Tithe Creek Ponds	4,200	80.77	4,700	48.96	6,600	57.89	3,600	36.36	12,700	77.92	57.94
KULUKAK SYSTEM TOT.	5,200	100.00	9,600	100.00	11,400	100.00	9,800	100.00	16,300	100.00	
TOGIAK DISTRICT TOTAL	127,400		71,600		127,600		114,700		112,800		

1/ Estimated spawning population of Kulukak River and Lake combined, 1961-1964.

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Table 11. Comparison of total population of red salmon with sum of peak survey estimates in the Nushagak and Togiak districts, 1965.

Area	Total Pop. Est. by Tower Count	Sum of Peak Survey Estimates	Peak Accounted for by Peak Est.
Wood River Lakes	675,200	435,830	64.55
Igushik Lakes	180,800	80,500	44.52
Tikchik Lakes	203,100	94,790	46.67
Togiak Lakes	88,400	43,130	48.79
TOTAL	1,147,500	654,250	57.02

Table 12. Comparison of total population of red salmon by tower counts with sum of peak survey estimates in the Nushagak and Togiak districts, 1963-65.

		Percent Accounted for by Peak Survey Estimates			
Year	Wood River	Igushik River	Lake Nunavaugaluk	Tikchik Lakes	Togiak Lakes
1953	30.09	-	-	-	-
1954	24.19	-	-	-	-
1955	37.45	-	-	-	-
1956	38.56	-	-	-	-
1957	52.68	-	-	-	-
1958	46.03	53.26	-	-	-
1959	46.54	41.71	-	29.37	-
1960	47.39	43.55	48.25	31.33	40.48
1961	63.59	39.23	52.45	34.31	44.45
1962	49.71	48.66	51.11	41.50	44.09
1963	55.28	47.18	45.47	55.47	49.94
1964	49.85	46.11	63.71	49.88	49.90
1965	64.55	44.52	-	46.67	48.79
Geometric Mean	45.08	45.39	51.88	40.18	46.13

Note: Percent accounted for by peak survey estimates are derived only on systems with tower counts.

Table 13. Percentage distribution of red salmon spawners in three major types of spawning areas in the Nushagak and Togiak districts, 1959-65.

| Year | Spawning Area | | | Total Pop. Est. by Tower Counts |
	Creeks	Beaches	Rivers	
WOOD RIVER LAKES [1]				
1959	32.75	50.30	16.95	2,209,300
1960	27.37	55.50	17.13	1,016,100
1961	11.43	32.31	56.26	460,700
1962	23.97	65.23	10.80	873,900
1963	12.15	68.48	19.37	721,400
1964	18.65	54.06	27.29	1,076,100
1965	11.09	23.41	65.50	675,200
Average [2]	18.03	46.99	25.00	1,004,700
IGUSHIK LAKES [3]				
1959	34.30	48.20	17.50	643,800
1960	35.50	52.90	11.60	495,100
1961	39.34	34.54	26.12	294,300
1962	43.40	31.55	25.05	15,700
1963	6.21	44.81	48.98	92,200
1964	27.59	38.57	33.84	128,500
1965	23.08	59.28	17.64	180,800
Average [2]	26.06	43.25	23.44	264,300
LAKE NUNAVAUGALUK				
1959	41.70	57.60	0.70	140,000 [4]
1960	44.30	50.70	5.00	16,600
1961	24.12	71.99	3.89	4,900
1962	29.35	63.04	7.61	1,800
1963	22.69	76.13	1.18	38,000
1964	20.89	78.48	0.63	12,400
1965	22.92	74.48	2.60	12,000 [4]
Average [2]	28.18	66.68	1.54	32,200
TIKCHIK LAKES [5]				
1959	24.10	37.90	38.00	48,900
1960	19.40	53.10	27.50	145,500
1961	11.19	49.63	39.18	79,800
1962	9.49	64.66	25.85	37,900
1963	19.69	29.95	50.36	166,600
1964	5.59	87.22	7.19	103,200
1965	11.20	71.50	17.30	203,100
Average [2]	12.94	53.21	25.29	112,100

Table 13 (Continued)

Year	Spawning Area			Total Pop. Est. by Tower Counts
	Creeks	Beaches	Rivers	

TOGIAK LAKES

Year	Creeks	Beaches	Rivers	Total Pop. Est. by Tower Counts
1959	12.80	82.59	4.61	178,700 [4/]
1960	12.30	74.56	13.14	162,800
1961	15.89	69.97	14.14	95,500
1962	11.39	54.64	33.97	47,400
1963	4.35	84.03	11.62	102,400
1964	3.14	89.94	6.92	95,600
1965	5.45	69.90	24.65	88,400
Average [2/]	8.02	74.30	12.82	110,100
TOTAL [2/]	16.87	55.72	12.39	

[1/]   River spawning category includes the Narrows on Lake Mikchalk.

[2/]   Geometric mean.

[3/]   Ongoke River population included in creek spawning category.

[4/]   Aerial survey estimates.

[5/]   Rapids between Nuyakuk Lake and Lake Chauekuktuli is included in river spawning category.